Scintillators for Gamma Spectroscopy

Gamma spectroscopy with fast beams using **Ge-detectors** (like SeGA)
Fact 1: Energy resolution is dominated by Doppler broadening → FWHM ~ 3%
Fact 2: Efficiency is quite low → ε~2-3% (SeGA)
Fact 3: VERY expensive to upgrade

Gamma spectroscopy with fast beams using **scintillators**
Fact 1: Energy resolution is dominated by intrinsic detector resolution
Fact 2: Comparably cheap detection systems with high detection efficiency

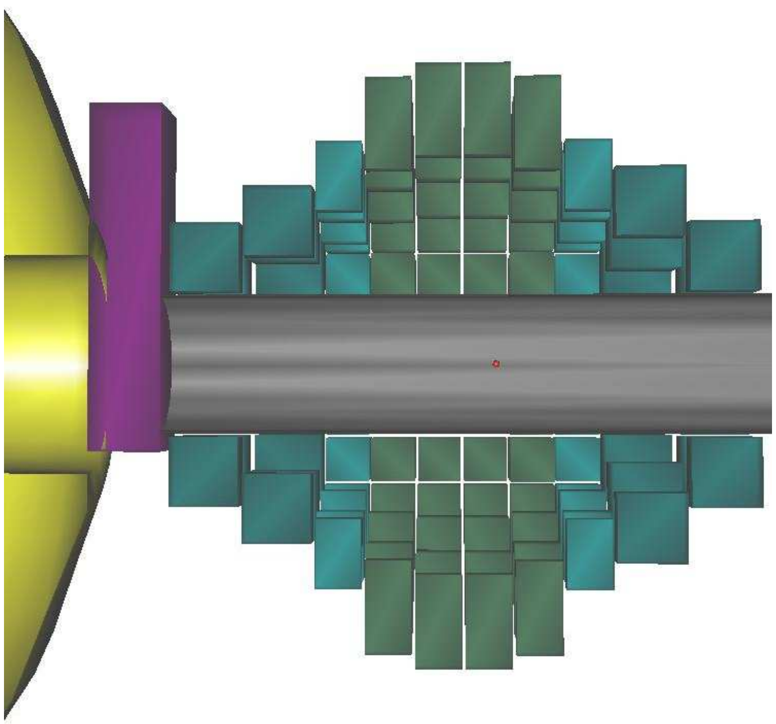
Question:
Is it worthwhile to sacrifice energy resolution (factor 3)
for gaining efficiency (order of magnitude)?

Examples (40% γ-ray detection efficiency):

Coulex	2 pps	, 300 mg Au, 500 mb: 132 detected gammas
Knockout	2 pps	, 300 mg Be, 25 mb: 144 detected gammas
2p-KO or **exchange**	100 pps	, 500 mg Be, 0.1 mb: 48 detected gammas

….but can we resolve those in a real-life spectrum with background?

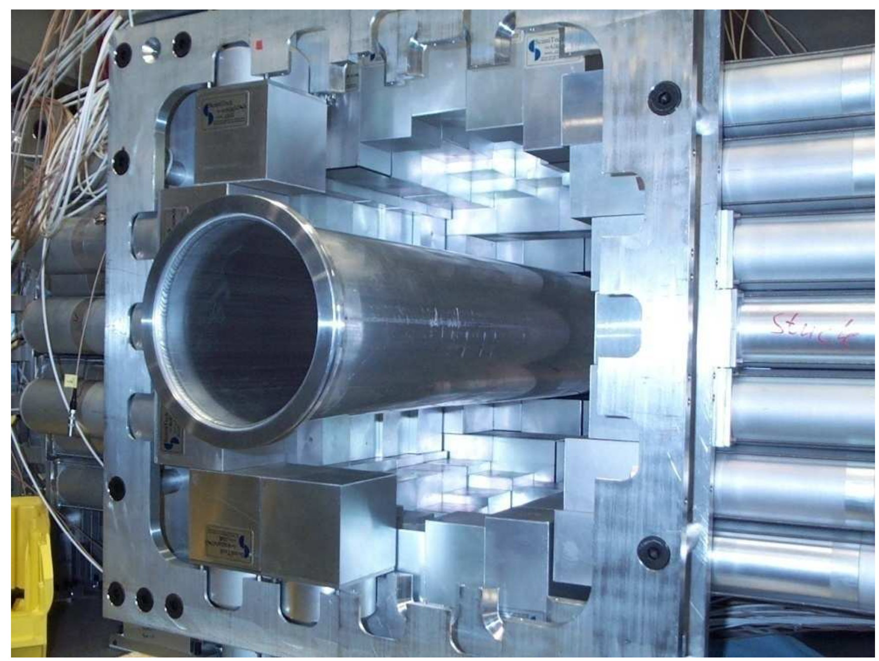
Geometry of CAESAR



- 48   3"x 3"x 3" CsI(Na) crystals
- 144 2"x 2"x 4" CsI(Na) crystals

Advantage:
- Simple detector shape
- Low impact of gaps on solid angle coverage

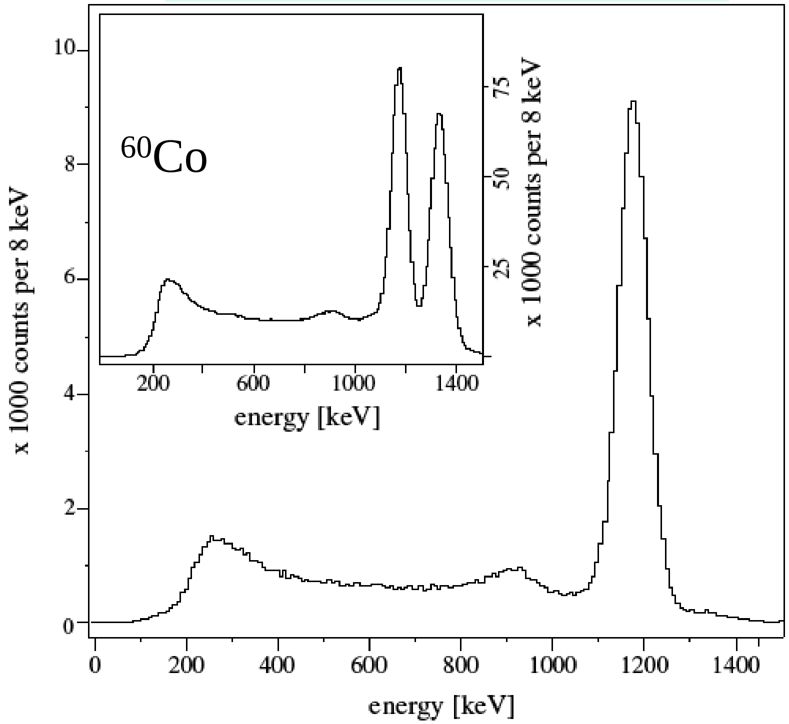
Drawback:
- Not spherically symmetric



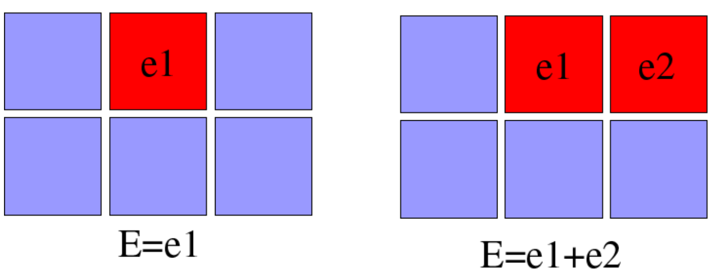
Design goal was:
40% efficiency and 10% FWHM
at 1MeV and v/c=0.4

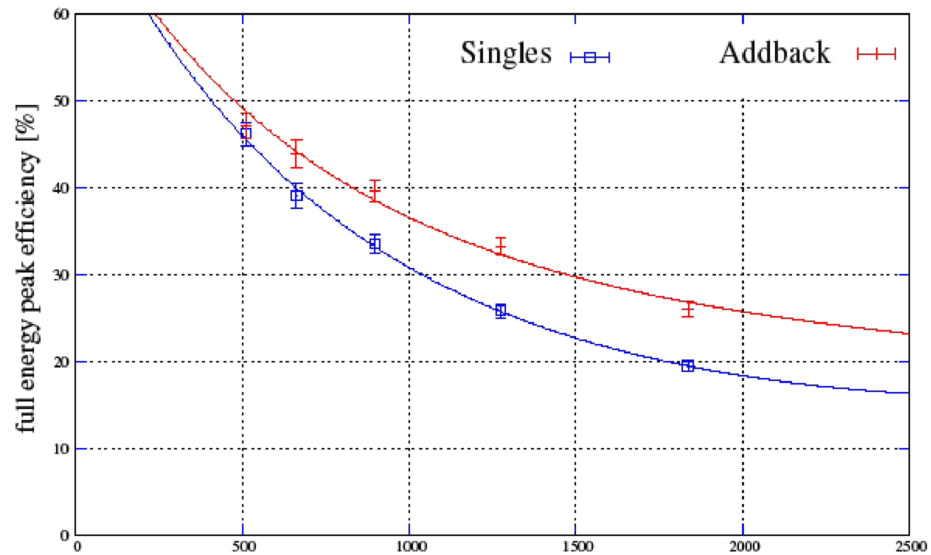
Source performance

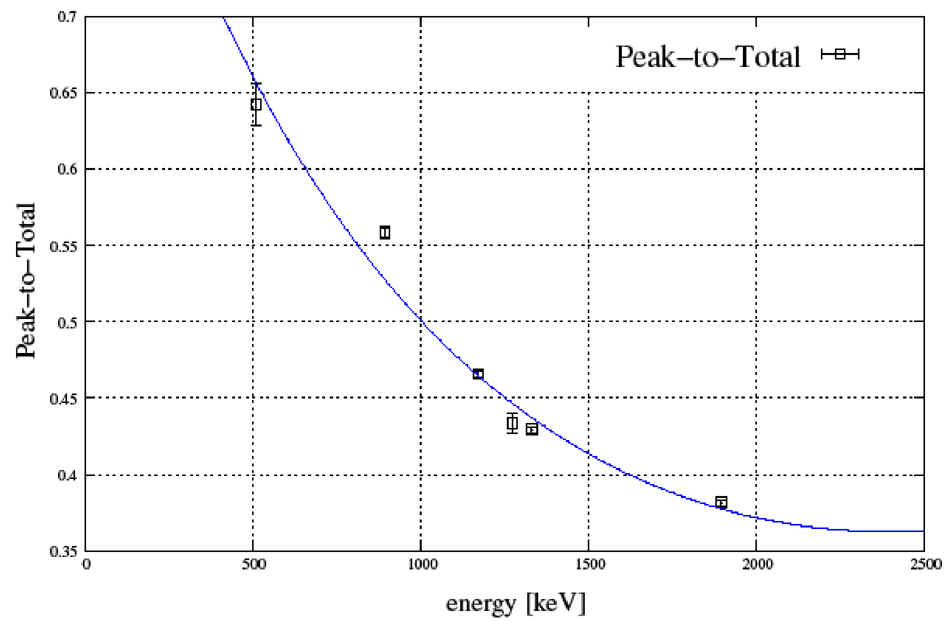
Coincidence with 1.3 MeV



Addback: Recover energy of γ scattered between two neighboring crystals



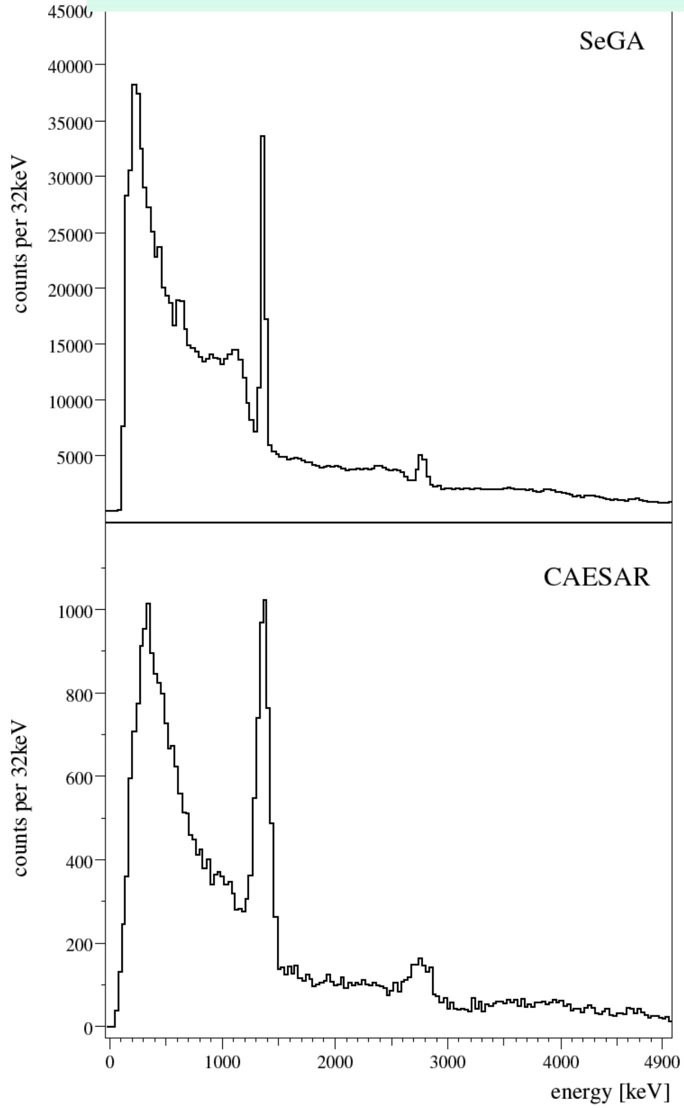


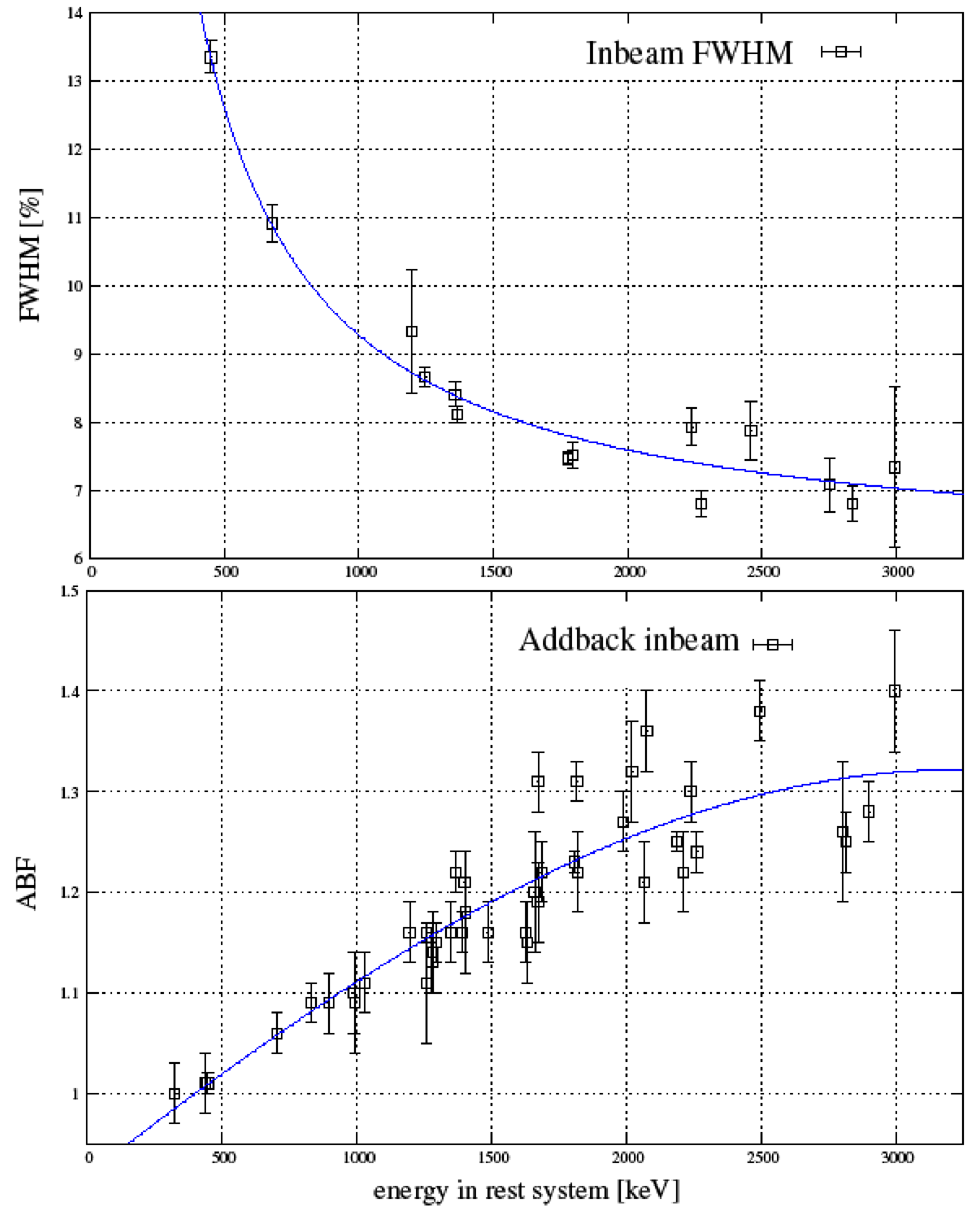


In-beam performance

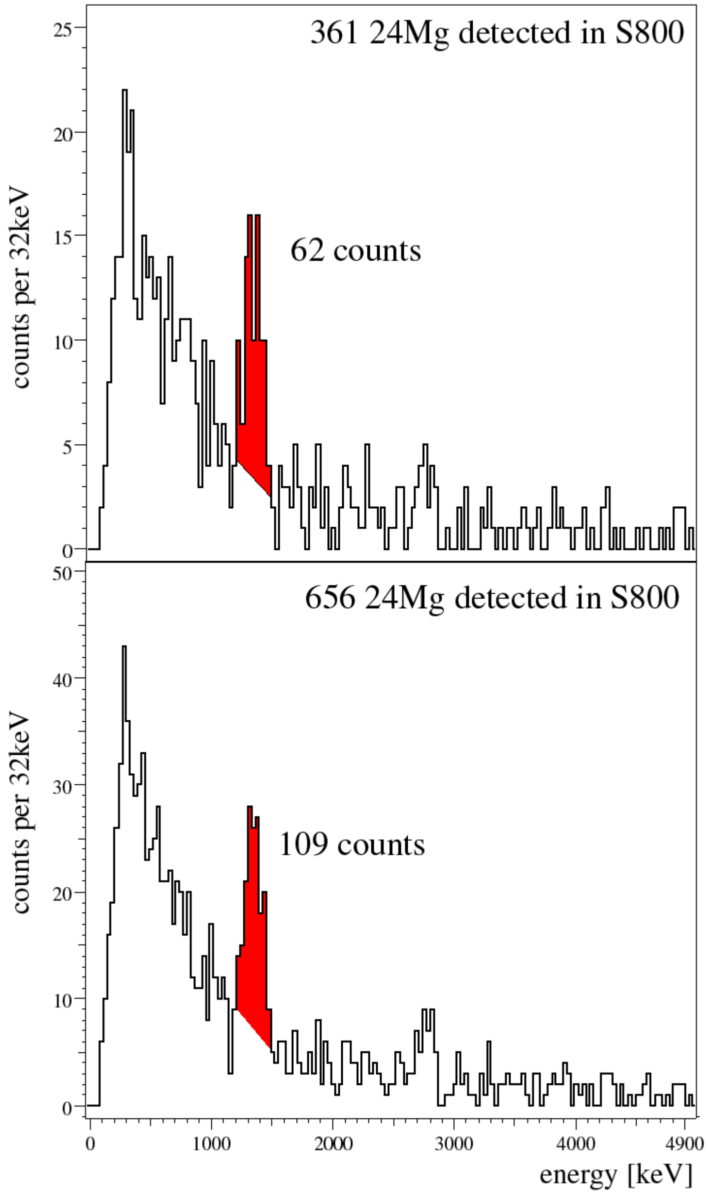
^{24}Mg, v/c=0.35

via secondary fragmentation on Be

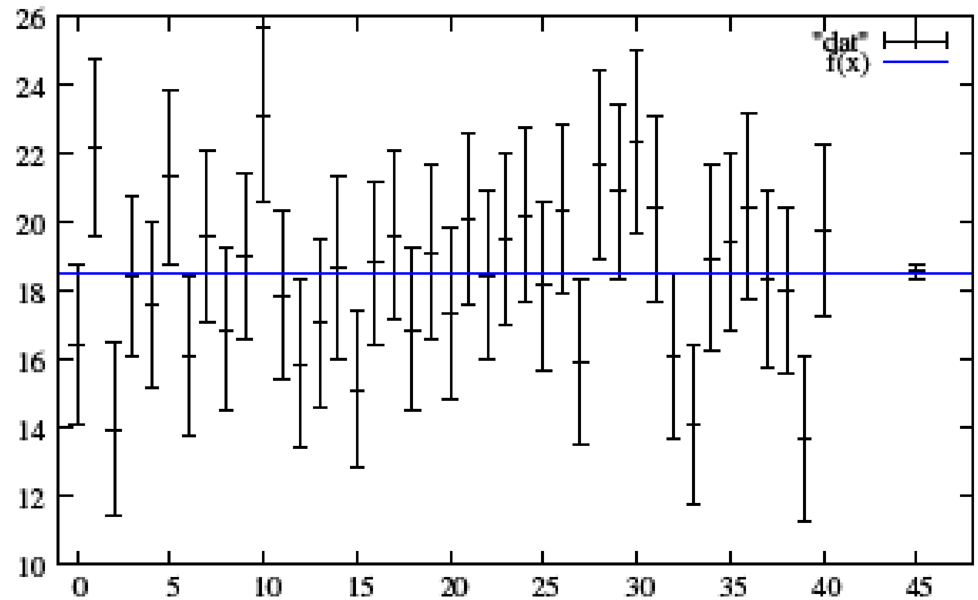




In-beam: Low statistics



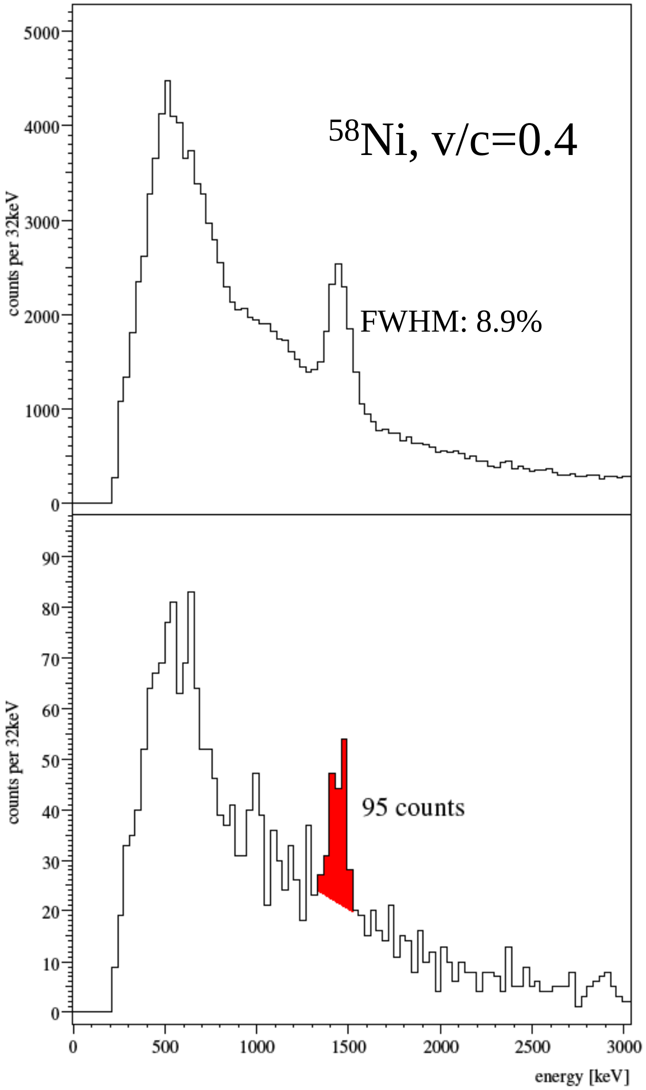
$^{9}Be(^{33}Cl,^{24}Mg)X$ at 65 MeV/u

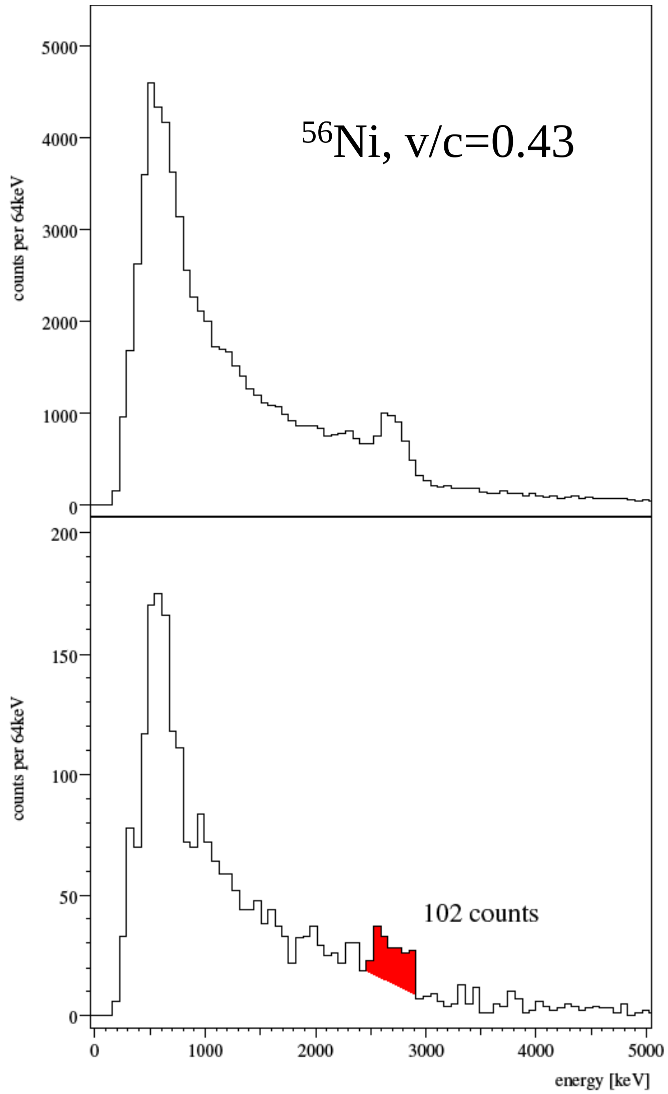


Gamma yield #gamma/#(^{24}Mg in S800) for various chunks of data with ~100 γ's and ~500 ^{24}Mg in S800 (points 0-40)

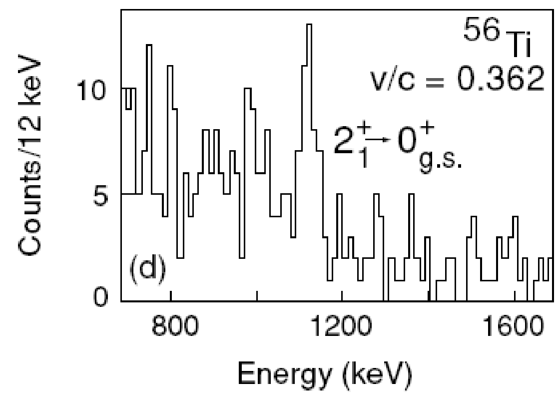
Point 45 from using full statistics.

Coulex spectra





Low statistics case
in SeGA



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